LBNL SAFETY REVIEW COMMITTEE

Triennial Review of the Management of Environment, Safety, and Health

Materials Sciences Division
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Review of the Materials Sciences Division
Management of Environment, Safety, and Health (MESH)

September 2006

A. Executive Summary

Materials Sciences Division's (MSD's) safety program has undergone significant change in the past couple of years, as new facilities, hazards, and key staff have been introduced into Division activities. These changes are reflected in the implementation of the safety program, as the Division is still in the process of establishing the safety program that Division management seeks. The MESH team noted several concerns and multiple noteworthy practices in MSD's implementation of integrated safety management.

The most significant concern of the MESH team is the responsibility for safety that is placed on postdocs, graduate students, and students. Due to the demographics of the division, guests and students outnumber permanent staff. This has created conditions in which students are managing the safety of multiple laboratories and other students, as permanent staff aren't numerous enough to perform these duties.

An institutional concern is that the Facilities organization should make greater efforts to partner with the Division in controlling hazards. Several MSD employees cited unreasonable Facilities costs as contributing to the slow implementation of appropriate hazard controls.

Other concerns include the fact that the Integrated Safety Management (ISM) Plan has not been signed by Division management since 2002, and that compliance with waste storage requirements is a chronic challenge. The outdated ISM Plan is a concern for both the Division and the institution. Although the plan was updated and reviewed by EHS Division in 2004, neither party ensured that a final plan was developed and authorized. The difficulties with waste storage may indicate a cultural challenge for the Division. When MSD issued fines for Satellite Accumulation Area (SAA) noncompliance in past years, performance improved significantly. However, when the fines were suspended, performance reverted to pre-fine levels. This indicates that Division management failed to adequately communicate the importance of authorization compliance to line management and staff.

The MESH team recognizes several noteworthy practices in MSD's implementation of ISM. The Division has made a concerted effort to strengthen their safety program in the past year, hiring an experienced safety professional as safety coordinator and also expanding the support staff for this position. MSD has also instituted fines and other disciplinary actions for safety violations, a statement that should improve safety awareness among Division staff. Finally, the Division complements this by soliciting Division Safety Coordinator input into the performance review process, as safety accounts for ten percent of each Principal Investigator's (PI's) performance.

B. Description of Division

Materials Sciences Division staff work onsite in buildings 2, 6, 62, 66, 67 (The Molecular Foundry), 70A, and 72 and several buildings on the University of California (UC) Berkeley campus. The division is composed of approximately 600 people. Of this total, approximately 250 are students, graduate students, and postdoctoral fellows; another 172 are guests. Many of the division's 74 principal investigators (PI's) hold joint appointments with UC Berkeley. The division is organized into six areas of research: the Center for X-Ray Optics, the National Center for Electron Microscopy (NCEM), The Molecular Foundry (TMF), Condensed Matter Physics programs, Materials Chemistry programs, and Materials and Engineering Physics programs. NCEM and TMF are large user facilities that accept proposals from scientists around the world.

MSD has hired a full-time Facility and EH&S Manager who also functions as the Division Safety Coordinator to manage the Division safety program. The Division Safety Coordinator is assisted by a safety technician and one full time and two part time building managers. The Safety Coordinator reports to the Division Deputy Director. The Division also has a division-wide Safety Committee that includes the Division Deputy, the Division Safety Coordinator, EHS Division Liaison, representatives from each hill-based PI's lab, and other division safety staff. The Division-wide committee met three times in fiscal year 2006. The Molecular Foundry created a safety subcommittee in May 2006 that includes representatives from each of the six Foundry scientific programs. This subcommittee has met twice since forming.

MSD's most significant hazards include laser use, x-ray use, corrosive and toxic chemicals, electrical hazards, cryogens and pressure systems, and operations in two machine shops. The Division has many formal authorizations, including 21 activity hazard documents (AHD's), two radiological work authorizations (RWA's), three x-ray authorizations, two low activity source authorizations, one sealed source authorization (SSA), and two exempt determinations for human subjects.

C. Introduction: Description of the Appraisal Process

The objective of the MESH review is to evaluate the Division's management of environment, safety, and health in its research activities, focusing on the implementation and effectiveness of their ISM Plan. The review provides a peer research perspective on the state of ES&H in MSD.

The appraisal process included a review of the documentation provided by Materials Sciences, an opening meeting with representatives from MSD, staff interviews, and a walkthrough of staff workspace. The MESH review team consisted of Paul Blodgett, team leader from Environment, Health & Safety Division, Michael Banda from Computing Sciences Division, Richard Kadel from Physics Division, and John Chernowski from the Office of Contract Assurance.

The MESH team met with Materials Sciences staff on September 5, 2006. Division Director Paul Alivisatos, Deputy Director Mark Alper, and Safety Coordinator Rick Kelly met with the

MESH team and discussed the Division's safety programs. In addition to these individuals, the team interviewed Ian Sharp, Matt Langer, Jeong Park, Roger York, Shalini Sharma, Gabor Samorjai, Paul Tangney, and Jeff Bokor. The team also inspected MSD labs in Buildings 2, 66, and 67.

D. Results of the MESH Appraisal

The appraisal results are organized by the five core functions of Integrated Safety Management. Findings are broken into three categories: concerns, observations, and noteworthy practices. Concerns are clear cases of practices or conditions that do not comply with regulations or LBNL policy, and/or indicate inadequate ES&H management systems within the Division. Concerns are deficiencies and must be corrected. Observations indicate room for improvement. They may be practices and conditions that are not necessarily out of compliance as observed, but could lead to non-compliance if left unaddressed. Noteworthy practices are practices and conditions that are recognized for their excellence and should be considered for lab-wide application. All findings are based on documentation review, interviews with division staff, and workspace inspections.

1. Work Planning

A majority of MSD staff is composed of students, graduate students, and post-docs. This requires diligent work planning to address potential challenges posed to this high-risk population. However, the Division ISM Plan is several years out of date and supervision of students appears less than adequate.

Institutional Concern: Several MSD senior staff members mentioned the high cost of Facilities Division's equipment installation. For example, laser interlocks were originally estimated at $20,000 per room, including one week's engineering labor. These costs were eventually lowered to ~$7000 per room after negotiations with Facilities. We heard from several sources that Facilities typically comes in with a high cost and then lowers the cost at the first objection. Facilities' cost and labor estimating process should be reviewed or a mechanism to bring in outside vendors should be pursued. The MESH team notes that MSD management requires the proper safety modifications before work can proceed.

Concern: Except for the Molecular Foundry, the laboratories visited by the MESH team were mostly devoid of permanent LBNL staff. This places undue responsibility for day-to-day lab management on students and postdocs. The most egregious example is one graduate student was assigned by his advisor as the safety coordinator for his group. This requires periodic review of 12 laboratories and occupies 5-10 hrs of his time per week. This is an inappropriate responsibility for a single graduate student. We questioned, therefore, the role of the PI in safety management in his laboratories.

Concern: The division ISM plan was last updated and approved in 2002. A draft from 2004 was submitted to EHS Division, but never formally approved. EHS provided comments, but no final resolution occurred. MSD should address these comments and update their ISM Plan as expeditiously as possible.

Observation: A graduate student was fully authorized to work on a Class 4 laser after receiving on the job training (OJT) from the senior graduate student on the project. While PUB-3000 doesn't explicitly require the responsible PI to perform this training, it does require that other staff are formally designated to perform the training. However, the senior grad student in the laser lab lacked formal designation to perform the training in place of the PI.

Observation: Some senior scientists claimed that they were having trouble keeping up with the changing safety culture at the lab, and consequently their housekeeping or record keeping may not be up-to-date.

Observation: Three out of the four reportable accidents involved students. Although this reflects the division's demographics, most formal discussions about these accidents did not address student involvement. Students pose unique challenges: 1) they are probably less sophisticated than their mentors and supervisors, and 2) they are more likely to be on the front lines of research with the greater potential exposure to hazards. Division management should make greater effort to address these challenges.

Observation: The Molecular Foundry should institute a policy of no lead bricks or mercury containing thermometers in Building 67. This will ensure that the building remain free of mercury and lead contamination.

Noteworthy Practice: The division has a periodic newsletter (Materials Safety) that is sent to all employees stressing safety in the workplace and summarizing lessons learned and recent safety accidents.

Noteworthy Practice: The division is preparing a safety calendar that details the list of safety inspections, due dates for formal and informal (re)authorizations, etc. The MESH team suggests coordinating these activities with the Performance Review and Development (PRD) process.

Noteworthy Practice: MSD has taken significant steps to increase staffing of their safety program in the past year, hiring a new division safety coordinator, safety technician, and building manager. The division safety coordinator is a full-time, career safety professional, replacing an MSD researcher who performed the duties on a part-time basis.

2. Hazard Identification and Risk Analysis

MSD principal investigators are responsible for identifying and reviewing hazards. Several mechanisms exist to perform this activity, including reviewing research proposals and Work for Others requests and inspecting workspaces. PI's are responsible for identifying hazards that require formal authorization and working with EH&S Division to obtain required approvals prior

to commencing work. The safety coordinator works with researchers to help them identify work that requires formal authorization. The division safety committee does not have a formal role in this process.

Concern: The MSD safety coordinator is delaying putting up door entry signage on labs (both at TMF and the older buildings within the MSD) pending a redesign of the signs. This is a clear violation of the Chemical Hygiene and Safety Plan (CHSP). The safety coordinator stated that he is designing a better sign to post on the doors. This intent is recognized and appreciated, but uniform signs across LBNL are preferred because the activities of Facilities' trades and custodians and some scientists require them to be in multiple buildings and divisions. Keeping the current system that everyone is accustomed to and understands would seem appropriate. Whatever the final design, proper signage should immediately be applied to the labs, even if it is to be updated in a few months. Signs, placards, labels, etc., are commercially available through HCL Labels.

Concern: The MSD division director exhibited the right attitude about integrating ES&H into standard work practices during his interview. However, this message has not been effectively delivered to all MSD PIs and supervisors. The MESH team found safety violations in almost every lab, suggesting that PI's are not routinely and systematically reviewing their laboratory space for safety deficiencies (see examples listed in Attachment 1).

Observation: In an effort to improve the quality of management safety inspections, PI's should receive training to recognize common safety problems.

Noteworthy Practices: Several senior scientists mentioned that having EH&S 26 taught by peers in the division made the course more meaningful for them. The course incorporated safety information in a way that made it easier to understand without rote repetition of regulations. However, since many of the safety responsibilities within the division are born by graduate students, this training may be addressing the wrong audience or needs to address a wider audience.

3. Establishment of Controls

MSD has a wide array of formal authorizations in place to control hazards. The division uses Safety Assurance Statements to establish line management authorization for hazards that do not require formal authorization.

Concern: Equipment in a number of labs is bolted down and configured to result in less than 28" aisle width.

Observation: Many MSD labs have activities that are potentially hazardous but do not rise to the level of a formal authorization. Currently, each PI is asked to sign a statement that he or she has reviewed the other hazards in his lab; and states that the procedures, authorizations, and approvals are consistent with those documented in Pub 3000, the MSD project hazard guide, or the equivalent. This process lacks depth and detail. For example, the forms could include a

simple listing of potential hazards and respective controls in each lab. These forms could receive periodic updating by the PIs and review by the safety coordinator or safety committee.

Observation: According to the Division ISM Plan, work leaders must maintain records of line management authorizations, but the documentation was inadequate.

4. **Work Performance**

MSD staff incurred two recordable injuries in each of the past two years. Historically, MSD has had difficulty complying with authorizations, especially waste characterization and storage requirements and laser Activity Hazard Document's (AHD's).

Concern: The process of fining researchers for Satellite Accumulation Area (SAA) infractions appears to have merit, but it does not sustain a culture where ES&H is an important part of conducting the work. MSD began issuing fines a few years back, but suspended this penalty in the past year. SAA compliance improved when fines were actively issued, but the incidence of SAA noncompliance returned to pre-fine levels after the fine program was stopped.

Concern: The number of SAA's out of compliance has grown in the past year. Of the ~50 SAA's inspected four times in the last year, three were noncompliant on three out of four occasions, and ten failed on half the inspections. In one lab we inspected (building 2, room 221), a waste container had a start date from 2005, which may the subject of a Nonconformance and Corrective Action Report (NCAR), see detailed list below.

Concern: MSD stated that they are using TMF as a test bed for some new safety initiatives. However, we found no appreciable difference in attention to safety at TMF compared to other MSD workspaces. Examples of deficiencies at TMF include:

1. Two labs had SAA violations.
2. Two out of three researchers in a chemistry lab were not wearing safety glasses. In fact, when this was brought to the attention of one employee not wearing safety glasses, he did not immediately don a pair, but rather finished his procedure before seeking out his eyewear. This is despite the fact that the safety coordinator stated that all staff working with hazardous chemicals are required to wear safety glasses.
3. The lower oxygen monitor in the Nuclear Magnetic Resonance (NMR) Spectroscopy Room was hanging from its signal cables. We understood that a request to Facilities to properly install the monitor had been placed 6 months earlier.

Concern: A lecture size bottle of nitrogen dioxide was found in a non-ventilated experimental apparatus in B66-407. Two deficiencies are related to this condition: 1) no AHD exists for use of this gas, and 2) it is not inventoried in the Chemical Management System (CMS).

Noteworthy Practice: The division is re-implementing fines against grants for SAA violations. Although this is admirable, the division should focus on pro-actively promoting a safe work

environment. The initial implementation of fines for SAA noncompliance did not manifest a culture change to result in lasting performance improvements.

Noteworthy Practice: The division has used disciplinary action against employees for safety violations, some resulting in salary reductions.

5. Feedback and Improvement

Primary mechanisms for feedback and improvement in MSD are lab inspections and walkthroughs by various parties, review of safety communications, review of PI lab inspections, and review of engineered hazard controls. Findings from inspections are diligently tracked in the Berkeley Lab Corrective Action Tracking System (CATS).

Concern: Some Supervisors Accident Analysis Reviews (SAAR's) were incomplete or contradictory. The MSD Safety coordinator stated that he and the responsible supervisor only receive a single e-mail indicating their obligation to fill out the form for a particular accident. However, considering their awareness of the employee injuries and roles in investigating injuries, reminders to complete SAAR's should not be necessary. This activity should be a natural product of employee injury response and investigation. One possible improvement to the SAAR notification system would be to notify the division director as well.

Noteworthy Practice: The division safety coordinator provides input to the P2R process on safety performance of each PI. This input constitutes 10% of the grade for the purposes of salary ranking.

Attachment 1: List of Workspace Safety Concerns

Building 66

General: 1) Unsealed lead bricks being used as door stops and nonessential parts of research apparatus.
2) Absence of required hazard information on chemicals in secondary containers.

Room 231: 1) Fume hood - blower labeled as not working on caution sign attached to hood door; however, ventilation was in operation.

Room 225: 1) Trip hazard on floor.

Room 224: 1) Blocked electrical panel.
2) Large equipment without seismic restraint.

Room 403: 1) Cables on floor without protection creating trip hazard.
2) Hand made "Do not enter room sign", not clear if operative.
3) Cooling pipes(?) attached to cable tray with bungee cord.
4) Copper wire used to tie cables to cable tray bracket.
5) Shared cabling (power and signal) in cable tray.

Room 407 1) Tangle of cables on floor near gas bottles at rear of lab.
2) H_2 gas with no chemical inventory label. Other gas cylinders not hazardous and are probably ok unlabeled, being oxygen or compressed air.
3) Discovered uncovered lead bricks strewn on floor.
4) Discovered lead bricks used to support experimental equipment from floor.
5) Large rolling experimental apparatus not fixed to floor.

Building 2

General: 1) Absence of required hazard information on chemicals in secondary containers.

Room 261: 1) Cable trays shared AC power and other services.
2) Heavy equipment laser table without seismic restraint.

Room 247a: 1) No chemical inventory label on methanol container.

Room 237: 1) Laser tables not bolted to floor.
2) Liquid nitrogen dewar not secured to wall.

Room 220: 1) Isle to narrow for access, less than 29 inches.

Room 263: 1) Secondary containment for bottles in storage locker missing.

Room 207: 1) Cable on floor creating trip hazard.

Room 221: 1) Labeled chemical waste (germanium arsinide "dust" from polishing with water plus abrasive) from 2005. Possible NCAR.
2) Above not situated in SAA (container did not fit in hood).

Room 220(?) (Haller lab) 1): Block and tackle hoist with hemp rope employed to lift vacuum tank lid. Check condition of rope, and robustness of connection to support.

Building 67

Room 6200: 1) Multiple items labeled as chemical waste not located in SAA.
2) Two ~½ gallon bottles of labeled, chemical waste stored in sinks.

Room 5209: 1) No secondary containment on SAA's near windows. Most bottles were empty but some bottles had contents.
2) Solvents in flammables cabinet not inventoried.
3) Two out of three workers in lab not wearing safety glasses. Safety glasses are mandatory in all chemistry labs according to the MSD Safety Coordinator.

NRM Room: 1) 'Lower' oxygen monitor (in case of a liquid nitrogen spill) hanging from signal cable.